The effective management of a recycling program at a large manufacturing facility

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THE EFFECTIVE MANAGEMENT OF
A RECYCLING PROGRAM AT A LARGE MANUFACTURING FACILITY

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Abstract

Some companies have realized the benefits associated with an effective recycling program. Xerox Corporation is one of those companies. Effective recycling can bring revenue to a company, while reducing costs associated with waste disposal. Additionally, they may be seen as good corporate citizens to their stakeholders, which can be used as an important marketing tool for the sales force.

This project examined the effective management of a recycling program at a large facility. Xerox Corporation’s facilities located in Monroe County, New York have had recycling programs in place for over a decade. Because the program was mature and continued to function, Xerox Environment, Health and Safety began to focus on other programs such as spill reduction and compliance with environmental regulations.

The project reviewed the current recycling programs and practices at Xerox Corporation’s largest facilities in Monroe County. It compared the recycling rate of these facilities to other Xerox sites and external companies.

This project found that Xerox Corporation’s Monroe County facilities have very effective recycling programs. The facilities are complex, which makes it more difficult to maximize their recycling performances. However, the facilities can improve the recycle rate by making the staff more aware and accountable for the recycling processes. Some areas within Monroe County do not track the materials that are reused internally. Additionally, opportunities should be explored to divert some packaging wastes from the landfill to a recycling outlet.

This project also showed that a team approach is needed to ensure the changes are implemented and communicated effectively.

In summary, achieving the highest reuse and recycling rate that is economically feasible and responsible for the facility to maintain its competitiveness characterize effective management of a recycling program.

Key Words: benchmarking, commingled; compactor; construction & demolition wastes; contaminant; corrugated; disposal; electronics scrap; energy recovery; fiber; International Organization for Standardization; ISO 14001; landfill; leasehold; mixed paper; OCC; packaging; pallet; recyclable; recycle; recycle stream; reuse/recycle rate; remanufacturing; reuse; solid waste; waste container audit; waste stream.
1.0 Introduction

1.1 Topic

The topic to be investigated in this project is the effective management of a recycling program at a large manufacturing facility. An effectively managed recycling program should result in the highest recycling rate that is attainable at a facility in a cost-effective manner. Facilities could easily attain the goal established as a corporate initiative of “Zero-to-Landfill”. However, it may also be very expensive to do so. The primary objective of this project is to determine if the current recycling program is being effectively managed or opportunities exist to improve the recycling program at Xerox Corporation’s largest facilities, located in Monroe County, New York. Opportunity is measured by the gap between these Monroe County facilities and the rest of the corporation.

This topic will be studied through a variety of means. A review of literature will be completed describing the current recycling trends and expected benefits to industry. In addition, a review of the regulatory requirements adopted by local, state and federal agencies that mandate recycling programs will be completed. Also, a detailed examination of the current recycling program at one Xerox facility within the United States will be conducted and a comparison of it to the recycling performances at other large Xerox manufacturing facilities and other companies will be made.
1.2 Significance of Topic

Corporate environments are changing and business is becoming more competitive. Every opportunity to raise corporate profits needs to be examined – from instilling operational efficiencies to reducing large-scale capital costs or providing simple solutions to the more complex. One important example of these efficiencies is a waste reduction program. Through the implementation of such an undertaking, corporations have been known to save hundreds of thousands of dollars annually (Xerox 1).

Multi-national corporations are no longer loyal to one facility or another. They conduct their decision-making largely based on the bottom line of the corporate balance sheet. While they set corporate objectives and targets, they review each facility and the operational costs associated with manufacturing of goods at those facilities. If they see opportunities to reduce the overall costs by moving operations, they will do so, assuming it makes good business sense.

In addition, each facility contributes to the environmental performance of the corporation. Corporations have used this performance as a marketing tool for their products as consumers have become more environmentally aware. Private sector concern entered the arena of competition for market share when consumption behavior analyses revealed that environmentally responsible target markets were becoming increasingly significant and warranted development of environment-oriented consumer affairs or marketing programs (Morelli 14).

This topic is significant and worthy of study because it may provide the facility with an opportunity to improve on an already mature recycling program. Additionally, the
Improvements may result in reduced operating costs, which will aid the facility in becoming more cost-competitive. It may also provide managers with an understanding as to whether one can easily and completely compare facilities of varying size and operations within a corporation.

1.3 Reason for Interest

There are several reasons for interest in pursuing this topic of study. The findings may improve the coordination and overall performance of the recycling program at Xerox Corporation's facilities located in Monroe County, New York. The information found in this project may open the door for assistance to other Xerox facilities through best practices sharing. The Xerox Environment, Health and Safety management team has asked for a review of the current recycling initiatives and an understanding of the disparity between Monroe County and the rest of the corporation.

There also exist some very personal reasons for the importance of researching this topic. As the global economy continues to expand and multi-national corporations, such as Xerox make business decisions that ultimately affect their bottom lines, the Monroe County facilities, specifically the Webster, New York facility, must remain competitive in order to help preserve jobs in the area. Monroe County has lost a number of manufacturing jobs over the last several years to lower operating expenses. Effectively executed Reduce-Reuse-Recycling, or 3R's, programs can significantly lower expenses and preserve natural resources, which will only continue to grow in importance in the future.
Bale: the end product of a compaction process that is used to decrease the volume that material occupies by increasing the density and weight. Bales are typically 3' x 4' x 5' and must be bound with plastic stripping or wire to keep from falling apart.

Benchmarking: to measure another’s product or process according to specified standards in order to compare it with and improve one’s own product or process.

Bin: the intermediate recycling or garbage container, located at a convenient distance to a number of employees.

Commingled: recyclable wastes that are mixed together for collection purposes. Commingled material is not recyclable unless it is separated after collection.

Compactor: any power-driven mechanical equipment designed to compress waste materials.

Compost: an organic soil conditioner that has been stabilized to a humus-like product that is free of viable human and plant pathogens and plant seeds, that does not attracts insects or other vectors (organisms that transmit pathogens), that can be handled and stored without nuisance, and that is beneficial to the growth of plants.

Construction & Demolition Wastes (C&D Wastes): solid waste materials resulting from the construction, remodeling, repair, or demolition of buildings, bridges, pavements, and similar structures. Normally, construction and demolition materials from residential sources are not included in the definition of C&D wastes.

Contaminant: an unwanted or undesirable component of a product or process that diminishes its recyclability.

Corrugated: paper products made from stiff pasteboard formed into fluted ridges and grooves.

Densification: a process that lowers the volume-to-weight ratio in order to reduce shipping costs. Baling is the most common form of densification, although some handlers of post-consumer plastic plastics granulate or grind collected material.

Design for Recycling: this concept aims to encourage pre-production planning for safe and efficient recycling by the elimination, as much as possible, of hazardous and non-recyclable materials from the production process.
Disposal: discarding of materials or waste that has no significant recyclable value.

Diversion: the act of diverting one or more designated materials from a solid waste stream. Diversion typically occurs at the point of generation. Normally, diversion is used to divert recyclables for separate collection, but it may also be used to prevent certain materials from being managed with the rest of a solid waste stream.

Dumpster: the central storage container used to hold consolidated material for collection by the hauler.

Electronics scrap: materials that are excluded from hazardous waste regulations provided they are recycled. Included are personal computers, monitors, and circuit boards.

Energy recovery: a process in which waste material is burned, reducing the volume of the waste and producing steam for heating or generating electricity. (Also, Waste-to-Energy)

Expanded polystyrene (EPS): polystyrene foam that is very light and bulky. It is commonly known by its trade name Styrofoam.

Fiber: the unit cell of vegetable growth derived from wood, cotton, etc. Usually many times longer than its diameter, it is the basic physical unit of paper pulps.

Front-end loader collection vehicle: a collection vehicle with two forks on front arms to lift a container to empty the solid waste into a hopper at the top of the compaction body. Compaction of solid waste is from the front to the rear of the compaction body. This body type is used primarily for the collection of commercial, institutional and industrial solid wastes. However, it has been adapted for the collection of residential solid waste and recyclables.

Front-end loader container - a solid waste storage container specially designed for use with a front-end loader collection vehicle. Frequently referred to as a "bin".

Hauler: a transporter of material from one location to another (e.g., a recyclable material from a collection facility to a recycling facility).

High-density polyethylene (HDPE): used to make bottles for milk, juice, water and laundry products. Unpigmented bottles are translucent, have good barrier properties and stiffness, and are well suited to packaging products with a short shelf life such as milk. Because HDPE has good chemical resistance, it is used for packaging many household and industrial chemicals such as detergents and bleach. Pigmented HDPE bottles have better stress crack resistance than unpigmented HDPE bottles.

Incineration: the process of waste volume reduction by combustion. This is not considered beneficially managed waste.
International Organization for Standardization (ISO): organization that develops voluntary standards that can be used globally.

Inverse Manufacturing: conventional production methods consider only design, production, and use of a product, while little attention is paid to disposal, reuse, and recycling. Inverse manufacturing solves this problem by approaching production not just from the forward process, but from the “inverse” process as well.

ISO 14001: international voluntary standard which specifies requirements for an environmental management system which will enable an organization to formulate a policy and objectives taking into account legislative requirements and information about significant environmental impacts.

Landfill: disposal of a waste material in or on the land at a location where it is permitted to dispose of hazardous or non-hazardous solid waste. For this discussion, it does not include hazardous waste disposal.

Leasehold: property held by lease.

Low-density polyethylene (LDPE): used predominately in film applications due to its toughness, flexibility and relative transparency, making it popular for use in applications where heat sealing is necessary. LDPE is also used to manufacture some flexible lids and bottles and it is used in wire and cable applications.

Materials Recovery Facility (MRF): a facility that receives materials in a form unacceptable by the marketplace. The MRF separates, removes contamination, sorts, densifies, and stores recyclable material types. Each material is prepared to meet the requirements of a specific market. MRFs are generally considered handlers.

Mixed paper: variety of waste paper that has not been separated by type and does not contain food waste or other major contaminants.

Monroe County DES: Monroe County Department of Environmental Services, located in New York State. Responsible for overseeing countywide recycling program.

Municipal Solid Waste (MSW): a solid waste stream composed of the following distinct solid waste streams

1. Residential Solid Waste - solid wastes generated by single and multifamily residences/dwellings/households.
2. Commercial Solid Waste - solid wastes generated by commercial enterprises, including offices, stores, retail and wholesale outlets, office buildings, markets, theaters, hospitals [non-infectious solid waste] and other commercial enterprises that would generate solid wastes similar in characteristics as the enterprises listed.
3. Industrial Solid Waste - solid wastes, which is similar in physical, chemical and biological characteristics to commercial and residential solid waste, are non-
hazardous, and non-process related and would normally be generated by offices, warehouses, cafeterias and shipping activities in industrial operations. Frequently referred to as "light industrial" solid waste.

4. Institutional Solid Waste - solid wastes generated by social, charitable, and educational activities.

OCC: Old corrugated containers.

Outsource: to send out (work, for example) to an outside provided or manufacturer in order to cut costs.

Packaging: materials such as plastic, foam, corrugated cardboard, and paper that are used to contain, protect, and transport products.

Pallet: a wood platform used for moving and storage of shipments, bales, or other large items.

Polyethylene terephthalate (PET): commonly used in soft drink bottles and many injection molded consumer product containers. Other applications include strapping and both food and non-food containers. PET is clear, tough, and has good gas and moisture barrier properties.

Rear loader collection vehicle: a solid waste collection body where the hopper for loading the solid waste is at the rear of the compaction body. Compaction of solid waste is from the rear to the front of the compaction body. This body type is used primarily for residential solid waste collection. However, it has been adapted for the collection of commercial, institutional, and light industrial solid wastes.

Recyclable: a product or material that can be reused or recycled. Included are paper, plastic, corrugated cardboard, wood, glass, electronics, and metal.

Recycle: the process of reusing an item by converting it to another state or by reclaiming valuable resources for another use.

Recycle stream: a general term used to describe all the recyclables generated in an area or facility.

Reuse / recycle rate: the percent of reusable or recycled materials removed from the waste stream in a specific unit (e.g., facility, corporation).

Remanufacturing: the manufacturing process of recycling a machine or part by disassembling to a predetermined standard with defective components replaced by new, reprocessed, or used components.

Reuse: using an item again for its original purpose or for a new purpose.
Solid waste: any garbage, refuse, trash, dry sludge, recyclable, or material that is discarded or abandoned and is intended for disposal. For this discussion, it does not include hazardous wastes.

Solid Waste Management: the systematic organization and administration of activities which provide for the planning, financing, and operational processes for managing solid waste. Operational processes include storage, separation, collection, transport, treatment, separation, diversion for other management purposes, recycling, composting, and landfilling of solid waste. The generation of solid waste is not a part of solid waste management.

Solid Waste Management Infrastructure: the basic, underlying framework or features of a system or organization to manage solid waste, including institutional, financial, regulatory, operational, and organizational processes.

Stakeholder: any party that has an interest in an organization. Stakeholders of a company include stockholders, bondholders, customers, suppliers, employees, and neighbors.

Waste container audit: an analysis of the contents of a waste container to determine the effectiveness of a facility’s solid waste management system.

Waste stream: a general term used to describe all the garbage generated in an area or facility.
While the concept of *Reduce-Reuse-Recycle* has been around for several decades, it has been receiving greater attention by multi-national corporations over the last ten years or so. There are many reasons for their interest: regulatory agencies, economic benefits, consumer awareness, and development of internationally recognized standards.

As a means to reduce the amount of solid waste being sent to landfills, many states passed recycling laws in the late 1980s and early 1990s. As of 1993, approximately 40 states were collecting and maintaining data on recycling; 26 of these actually calculated a recycling rate (EPA 1). Companies were required to develop recycling programs and quantify the amount of solid waste that was diverted from the landfills. They could no longer dispose of recyclable materials if they could identify a cost effective way to segregate them from the general waste stream. Monroe County adopted a recycling law in 1991, which stated that municipalities and businesses had to begin recycling. However, it did not specify a targeted recycling rate. Xerox’s Monroe County facilities developed and implemented a program to comply with this requirement. A complete analysis of the waste streams was conducted. Each facility purchased several containers and bins that enabled the employees in the offices and the factories to separate recyclables more easily. Awareness training was provided across the facilities.

Companies realized economic benefits as well. During the 1990’s, the economy underwent a globalization. As the market expanded beyond the shores of the United States, companies had to address the concerns of overseas consumers. European countries, such as Germany, began requiring products to be tested and approved to use
their "eco-friendly" labels. These labels help consumers identify products that are energy efficient, use recycled or recyclable materials, minimize the use of hazardous materials, and reduce pollution (Xerox 41). Additionally, the American consumers became increasingly more aware of the environment and the negative or positive impact that humans have on it.

The biggest driver of the development of recycling programs within industry came in 1996. The International Organization for Standardization began approving a series of ISO 14000 environmental management standards. Companies adopt these standards voluntarily. While there is a great deal of work in maintaining an ISO 14001 registration, companies recognize the impact the registration has on their bottom lines. The ISO 14000 series can be used as a marketing tool by the sales force for potential customers who are concerned with the product’s impact on the environment.

The integration of ISO 14000 into the business can result in lower manufacturing costs. A facility assesses its significant environmental aspects and develops programs to continually improve its performance. Facilities, specifically assembly operations, can generate a lot of solid waste when manufacturing a finished product. By identifying solid waste generation as a significant aspect, the facility can reduce its costs by finding alternatives to landfill. It may also find ways to reduce the amount of raw materials being used initially. Also, it can sell the scrap, such as scrap metal or corrugated cardboard, as a commodity, which will bring revenue to the operation, thus reducing the unit manufacturing cost. As a result of numerous waste reduction measures, Xerox Corporation was able to generate cost savings of approximately $47 million in 1999 (Xerox 1).
Xerox Corporation has long been considered an environmental leader. In fact, Xerox developed a remanufacturing process for its photocopiers over thirty years ago. Remanufacturing has resulted in significant cost savings for the corporation by reusing parts or using reconditioned parts from returned machines in rebuilt machines. The machines must pass the same stringent quality tests as new machines before they can be introduced back into the marketplace.

Recognizing the benefits that an effective environmental management system could bring to the company, in 1997, Xerox began registering its facilities through a third party auditing group in conformance with the ISO 14001 standard. The Monroe County manufacturing facilities were the first in the corporation to be registered. Other facilities followed in a systematic manner. Because the Monroe County facilities have the most mature program in the United States, it is the author’s opinion that they should have the best reuse / recycling rate. However, this has not proved to be true. In 2003, the Monroe County facilities reused or recycled 80% of the solid waste generated. However, the corporation had, as a whole, an overall reuse / recycle rate of 91%. The gap is even greater when the Monroe County facilities are removed from the total solid waste generated and recycled. The reuse / recycle rate for all other facilities was 93%.

Xerox has its largest manufacturing and office facilities in Monroe County, New York, employing approximately 9,100 people. The facilities have various operations and have undergone extensive changes over the last three years. Many of the manufacturing operations, primarily assembly, have been relocated to other Xerox facilities or outsourced, which has resulted in a change in the composition of the waste streams. The amount of scrap metals has decreased significantly. Scrap metals are easy to separate
from the waste stream and contribute substantially to the total waste generation. Large re-engineering projects have resulted in the generation of C&D debris, which is not easily segregated because of the tight schedules that must be followed. The project managers are instructed to recycle scrap metals and manage all other materials as wastes, including cardboard. These issues have resulted in an increase in the waste sent to the landfill.

Many people with experience in the recycling program have left the company. Over the last five years the focus was more on compliance with environmental regulatory requirements and less on other environmental programs. The recycling program was thought to be mature and effective and continued to function, so not as much emphasis was placed on it as was at other facilities. Therefore, recycling awareness training had not been conducted in quite some time.

The Monroe County facilities are complex in the way they are organized compared to many of the other Xerox facilities, particularly in the United States. Many of the other sites are dedicated to the production of one type of output, while the Monroe County facilities are comprised of many operations and organizations housed in the same buildings.

Examples of the variations in complexity include the toner manufacturing operations in Oklahoma City (OKC) and the surplus equipment management center in Cincinnati, Ohio. Each of the facilities is staffed in direct support of the specific operations performed. Because of the structure of the Monroe County facilities, it is difficult to make individuals accountable for the actions or lack of actions. People may overlook breaks in the process because they feel that they have no recourse over others’ processes.
Additionally, OKC and Cincinnati have Site Managers that are responsible for all aspects and performance. The Site Manager is a high-level manager within that organization and is responsible for the overall performance of the operation. Facilities Managers maintain the Monroe County facilities. However, they do not have the authority to make others accountable for their actions. The Facilities Managers can communicate the importance of recycling, but they cannot enforce the program.

The number of employees is significantly lower at each facility compared to the Monroe County facilities. This results in the generation of less cafeteria waste and more process waste proportionally. It is easier to develop recycling programs for process waste.

Organizations previously housed in leased facilities within Monroe County were relocated to the larger facilities in Webster, Henrietta and Xerox Square. Xerox Corporation did not invest much effort in establishing a recycling program in many of the leaseholds when the program was developed in the 1990s. Because of their lack of awareness, the employees have not entirely followed the recycling program.

These reasons have all likely contributed to the slower rate of improvement for the Monroe County facilities compared to the rest of the corporation.
3.0 Literature Review

3.1 Background Literature

3.1.1 Brief History of Recycling

Recycling is the collection and separation of materials arising from waste, and subsequent processing to produce marketable products. After serving its original purpose, recyclable material has, by definition, some value such that, in its remade form, the product has a new purpose and is not a waste. Recyclable material made into a similar product to the original is termed “primary recycling”. If the material is made into a different object, this is called “secondary recycling” (Dickes 19).

There are basic requirements for recycling. The waste must be collected and transported to be recycled. The waste must then be separated and cleaned before it can be processed to obtain marketable products. Types of recycled waste may also be divided into categories according to the part of the manufacturing process from which they have arisen. “Process-derived waste” can include unused starting materials, which can be returned directly to the production process, whereas “product-derived waste” will have to be reprocessed before being turned into useful commodities. “Ancillary waste” includes the packaging used for components and products (Dickes 19, 21). The recyclable wastes can be expensive to process, which sends a message to the generators
that recycling is cost-prohibitive and burdensome. While this barrier is difficult to overcome, industry has learned to adopt recycling practices as a means to do business.

Public pressure and concern provides an incentive to recycle. Environmental pressure groups have raised the public consciousness about environmental issues, who in turn, has applied pressures to various levels of government (Dickes 21).

The concept of recycling has been practiced for thousands of years. The Romans who pulled the stones from the Coliseum to pave highways were pioneers in construction and demolition recycling. The Germanic hero Siegfried, as portrayed in Richard Wagner’s operatic Ring cycle, rather than patching his great sword, melted it down and reforged it. He was practicing metal recycling. The steel industry in America has almost always recycled its old steel (Aquino preface). In the early 1900s, “junk collectors” would look through people’s garbage and remove pieces of metal scrap and other reusable items. They would sell the metal scrap to steel manufacturers, who would remelt the metal and add it to their product output. This would reduce the amount of raw materials being used. These entrepreneurs were not focused on the idea of reducing raw material usage at the time. There seemed to be an endless supply of raw materials. The entrepreneurs were only interested in an opportunity to increase their profits by utilizing existing goods in manufacturing.

In the 1970s, however, some members of the government and scientific community became concerned that humans were consuming raw materials at an alarming rate, which would eventually result in their depletion. Recycling began its slow trek toward becoming a part of everyday life for most Americans. What was new in the late twentieth century was the fervor with which recycling had been adopted. Many of the
United States set a certain level of recycling. By focusing on package recycling, Germany has reportedly brought the recycling level for packaging to 50%, due to mandated packaging recycling.

The fervor is due to a concern about the environment, about conserving our resources, and about the lack of landfill space in at least some of the United States and many other countries (Aquino preface).

A little over twenty years ago, only one curbside recycling program existed in the United States, which collected several materials at the curb. By 1998, 9,000 curbside programs and 12,000 recyclable drop-off centers had sprouted up across the nation. As of 1999, 480 Materials Recovery Facilities (MRFs) had been established to process the collected materials.

While recycling has grown in general, recycling of specific materials has grown even more drastically: 40 percent of all plastic soft drink bottles, 55 percent of all aluminum beer and soft drink cans, 57 percent of all steel packaging, and 52 percent of all major appliances are now recycled. In 1999, recycling and composting activities prevented about 64 million tons of material from ending up in landfills and incinerators.

In 2003 Americans recovered 49.3 million tons of paper for recycling. This represents 50 percent of all paper consumed in the United States. The amount of OCC and old newspapers recovered rose to record highs of 75.8 and 73 percent respectively. The amount of office paper rose to a record high of 48.3 percent. Americans recycle 270 million pounds of paper every day. More than 37 percent of the raw material used to make new paper products comes from recycled paper. Nearly 80 percent of all US paper makers use recovered fiber to make new paper products. Every ton of paper recovered
for recycling saves 3.3 cubic yards of landfill space. More paper is recovered for recycling than is landfilled. By weight, more paper is recovered from municipal waste streams for recycling than all glass, plastic and aluminum combined (Starnes 66).

In 2001, this country recycled 30 percent of its waste, a rate that almost doubled in 15 years (EPA Municipal Solid Waste).

![Waste Recycling Rates 1980-2001](image)

**Figure 3.1: US Waste Recycling Rates**

EPA’s goals for the nation are to recycle 35 percent of Municipal Solid Waste (MSW) generated; to reduce waste generation to 4.3 pounds per person per day; to empower state, local, and tribal governments to better manage solid waste; to provide leadership in source reduction and recycling; to build stronger public and private partnerships; and to ensure the environmental soundness of source reduction, recycling, combustion, and land disposal (EPA Municipal Solid Waste).
In this author's opinion, the EPA has set a lofty goal. However, it may be attainable through proper communication, accountability, and awareness training.

3.1.2 Benefits of Recycling

The benefits from recycling include the conservation of natural resources previously used for producing goods as well as energy savings in production of new parts and transportation of raw materials. Pollution has resulted in areas being banned from development until they have been cleaned to an acceptable level determined by state and federal agencies. Effective recycling reduces pollution; therefore the risks associated with pollution should be reduced. Because of the reduced waste volumes, there would be a reduction in costs associated with waste treatment and disposal. Additionally, the demand for waste disposal facilities and landfills would be lowered. Most importantly to corporations, recycling can result in producing goods more cheaply (Dickes 21).
Recycling prevents the emission of many greenhouse gases and water pollutants, saves energy, supplies valuable raw materials to industry, creates jobs, stimulates the development of greener technologies, conserves resources for our children's future, and reduces the need for new landfills and combustors.

Recycling also helps reduce greenhouse gas emissions that affect global climate. In 1996, recycling of solid waste in the United States prevented the release of 33 million tons of carbon into the air—roughly the amount emitted annually by 25 million cars (EPA I).

Each ton of solid waste that is diverted from disposal, whether reused, recycled or composted, is one less ton of solid waste that requires disposal. When the tonnage of reused, recycled and composted solid waste is considered in light of the disposal capacity required to accept that material, the value of these actions becomes very clear. By implementing these other resource management strategies, we have reduced our dependence upon incinerators and landfills. Pressure is reduced on expanding forestry and mining production when recycled materials are used in place of trees, metal ores and minerals. By recycling over 390,000 tons of scrap steel in 2000, Washington recycling efforts reduced the need for virgin materials by twice that amount, including 491,000 tons of iron ore, 275,000 tons of coal and 24,000 tons of limestone.

Recycling is more than a waste management strategy; it is also an important strategy for reducing the environmental impacts of industrial production. Supplying industry with recycled materials, instead of virgin resources extracted from forests and mines, is preferable because it saves energy, reduces emissions of greenhouse gases and other dangerous air and water pollutants, and because it conserves scarce natural resources. In
2000, Washington recycling programs supplied industry with over 3,900,000 tons of recycled commodities such as metals, plastics, paper, glass, wood and construction and demolition scrap.

Energy savings is an important environmental benefit of recycling, because using energy requires the consumption of fossil fuels and involves emissions of air and water pollutants. The energy required for manufacturing of paper, plastics, glass and metal from recycled materials is generally less than the energy required to produce them from virgin materials. Additionally, the steps in providing recycled materials to industry, including collection, processing and transportation, typically use less energy than the steps in supplying virgin materials to industry, including extraction, refinement, transportation and processing. The 1,522,506 tons of metals, paper, glass and plastic recycled in Washington in 2000 saved a total of about 23 trillion BTUs of energy, equal to nearly 3% of all energy used by industry in the state. This is enough to power over 23,000 homes, the equivalent of a small city for one year.

Recycling helps steam the dangers of global climate change by reducing the amount of energy used by industry, thus reducing greenhouse gas emissions. This is because a great of energy used in industrial processes and in transportation involves burning fossil fuels. Washington’s measured recycling efforts for the year 2000 reduced greenhouse gas emissions by about 1,280,000 tons carbon equivalent (Washington State DOE 1).

3.1.3 States Developed Programs
In recent years, many state and local governments have set recycling goals and implemented systems for determining their progress in meeting those goals. As of 1993, approximately 40 states were collecting and maintaining data on recycling; 26 of these calculated an actual recycling rate (EPA Measuring Recycling 1).

![Figure 3.3: State Recycling Rates - 1999](image)

New York adopted its recycling initiatives in the late 1980s. In 1987, the NYSDEC issued the first State Solid Waste Management Plan, which established a State goal to reuse or recycle 40 to 42 percent of the solid waste generated in New York State by 1997. Through the diligent efforts of local governments and the private sector, during the 1997 calendar year, New York State achieved its goal by reusing/recycling an estimated 42 percent of the solid waste generated in the State. In 1998, New York State once again recycled an estimated 42 percent of the solid waste generated (NYSDEC 3).

As a means to help New York State achieve its goal, Monroe County adopted a mandatory recycling law in 1991. The law states, in general, that residents must recycle...
steel, aluminum, glass, PET (#1) and HDPE (#2) plastics and paper (gable-top cartons/drink boxes) food and beverage containers. Empty steel aerosol cans may also be recycled. Residents must also recycle newspapers, magazines and corrugated cardboard. Large appliances are also required to be recycled.

Businesses, institutions, such as schools and colleges, and industries must recycle corrugated cardboard and high-grade office paper. Businesses and institutions that have cafeteria-type services and all restaurants must recycle the above listed containers (Monroe County DES). The county also specified annual reporting requirements by industries and waste haulers to ensure that the recycling was being done.

3.1.4 A Facility’s Response

When Monroe County adopted its recycling law, businesses were required to develop recycling programs that not only resulted in source separation, but also track the amounts of waste generated and reused or recycled. Xerox Corporation had a large manufacturing facility in Webster, New York and had to comply with the law. In 1992, its Corporate Environment, Health and Safety organization issued an internal recycling standard. Xerox, already considered an environmental leader, developed a tracking mechanism for its solid waste volumes in Monroe County.

In 1994, Xerox became a charter member of WasteWise. WasteWise is a free, voluntary, EPA sponsored program through which organizations eliminate costly municipal solid waste and select industrial wastes by identifying key waste reduction opportunities and developing processes to capture the opportunities. The participating
companies see WasteWise as a program that will enable them to improve their bottom lines and reduce their impacts on the environment. WasteWise is a flexible program that allows partners to design their own waste reduction programs tailored to their needs. All organizations within the United States may join the program. Large and small businesses from any industry sector are welcome to participate. Institutions, such as hospitals and universities, non-profits, and other organizations, as well as state, local, and tribal governments, are also eligible to participate in WasteWise (EPA WasteWise).

It was determined that the Xerox facilities would measure the amount of solid waste being generated and the amount of waste being reused internally or recycled through external recycling vendors. The rate would be calculated by dividing the total waste recycled by the total solid waste generated. The facilities could use this metric in tracking their efforts on waste reduction while complying with the requirements communicated by Monroe County DES.

**RECYCLING RATE = total reuse or recycle / total solid waste generated**

Xerox Corporation’s Monroe County facilities tracked this data through a variety of means. They received weights from their waste and recycling haulers for trash, paper, cardboard and metals. In addition, EH&S developed estimates of internal reuse of pallets and corrugated boxes with the manufacturing operations. They also quantified the amount of toner that was ground into fine particles and reintroduced to their finished products through extrusion.
3.1.5 Corporate Initiatives

In addition to the Monroe County recycling law, Xerox viewed waste as a sign of inefficiency. In 1991, the Environment, Health and Safety staff realized that it could significantly benefit the manufacturing operations by developing a waste minimization program. At the time the corporation had a reuse and recycling rate of about 55%. The staff set a corporate goal of 90% to be achieved by 2000. There was a great deal of skepticism within the corporation regarding the ability to achieve this goal (Azar). After a couple years of development, EH&S initiated a Waste-Free Factory program in 1993 aimed at minimizing the waste associated with manufacturing processes. Waste management and resource conservation programs are driven by the principles of Total Quality Management. Below are ways that Xerox began achieving Waste Free Factories (Waste Free Factory 1).

- Solid Waste Management
  - Pallet reuse/recycling
  - Corrugated and paper recycling
  - Standardized reusable parts boxes
  - Plastic and scrap metal recycling
  - Electronics recycling
- Energy Conservation
  - Automated lighting systems
  - Time clocks and occupancy sensors
  - Energy-efficient fixtures and lamps
  - Power Down / Profit Up program
- Post Consumer Material Usage
  - Toner containers made from recycled HDPE plastic
- Waste and Air Emission Management
  - CFC elimination
- Hazardous and Chemical Waste Management
  - Solvent free parts cleaning
  - Carbon dioxide cleaning process
- Communication and Training
  - Recycling
  - Waste Free concept

The Webster facility was the hub for manufacturing and distribution as well as the location of Corporate EH&S. It was a natural fit for the program to be implemented there in the early stages.

### 3.1.6 Program Implementation

EH&S identified the appropriate metrics and then worked with its solid waste vendor to implement a program. They developed a strategy that included pervasive awareness training and communication of the program. They set up recycling centers in the cafeterias and break areas for collection of paper, newsprint, magazines and recyclable containers. They conducted analyses of the wastes being generated at many of the facilities. This was commonly referred to as “dumpster diving.” The solid waste vendor would visually pick through the trash and quantify the amount of recyclable materials within them. This gave EH&S an idea of where to focus their efforts. The Monroe County facilities saw significant improvement in their recycling performances after the program was implemented. The facilities improved from a recycling rate of 55% at the program’s inception to around 70% in just a few years.

### 3.1.7 Impact of ISO 14001
In 1996, the International Organization for Standardization approved ISO 14000. Morelli states that ISO 14000 brings a system of environmental responsibility, management and compliance that will exist outside of EPA’s regulatory structure. Compliance with environmental law and regulation are component parts of the ISO 14000 design criteria for an environmental management system. This is specified under ISO 14001, the ISO standard that sets forth the criteria for establishing an appropriate environmental management system (EMS), and under which an organization’s EMS will be evaluated and certified. Compliance with all applicable environmental regulatory requirements is a stated goal of the ISO 14001 EMS standard, but the ISO 14001 EMS standard is not a performance standard (4). Certification of the ISO 14001 EMS standard does not necessarily mean that a facility is in compliance with all regulatory requirements.

Industry designed the ISO 14001 EMS standard, has ownership of it and is encouraging its implementation around the world. In order to be more competitive in the global market, US industries need to be able to respond quickly to marketplace demands. Industry needs to embrace environmental responsibility as its own and demonstrate that it is capable of handling it. ISO 14001 is a tool used by industry both to drive and demonstrate its environmental performance (Morelli 5).

The purpose of ISO 14001 is to provide organizations with the elements of an effective environmental management system to achieve environmental and economic goals. While regulatory compliance is not a stated purpose of the standard, its measurement, monitoring, documentation, and data management requirements provide an
organization's management with the information that it needs to determine its progress toward environmental objectives (Morelli 98).

Organizations may realize additional benefits. ISO 14001 requires organizations to establish and maintain verifiable procedures to make employees aware of the significance of the potential environmental impacts associated with their work as well as their responsibilities in managing those aspects. It provides a standardized EMS. It provides an EMS system with self-monitoring, self-policing, and self-correcting elements (Morelli 99). These lend themselves to continual improvement within an organization.

In 1997, Xerox Corporation began adopting the principles of ISO 14001 at its facilities. As previously discussed, ISO 14001 lends itself to operations and individuals taking ownership and being accountable for the environmental performance of their operations. Prior to ISO 14001, the burden was on EH&S to reduce the environmental impact of the facility, which was a difficult task at times. Operations had to meet or exceed production objectives, which included costs and volumes. Occasionally, they viewed EH&S as a barrier to meeting these objectives by requiring "unnecessary" demands. ISO 14001 made it easier for the corporation to meet its EH&S objectives. ISO 14001 also helped to operations to see the values associated with waste reduction initiatives.

The Webster manufacturing facility identified solid waste as one of its significant aspects. It focused on developing programs to reuse or recycle the waste generated from its operations. Webster was a leader within the corporation for solid waste recycling at the time.
The company expanded ISO 14001 commitment in the U.S. beyond its Webster facility. Eventually, its facilities in southern Ohio and Oklahoma City would meet the requirements for ISO 14001 registration. Today, Xerox Corporation has over twenty registered facilities worldwide. This has lent itself to an overall solid waste recycle rate of 91%.

3.2 Current Trends

3.2.1 Recycling

During the late 1990s, recycling programs were quite successful. There was a high demand for recyclable materials, which resulted in a significant revenue source to operations that generated the scrap. “Trash to Cash” became a battle cry for environmentalists and manufacturers. Managers began to include expected revenue when they would develop their operating budgets.

In 2000, the recycling markets began a downward trend. Paper and corrugated were being sold to mills for 25 to 50% of where they were at their highest point in the 1990s. White paper, which once sold for nearly $300 per ton, was being sold for under $100 per ton. The value of scrap metals decreased significantly as well. As the global economy began to grow, European and Asian steel suppliers found it much easier to compete in the US. Russia was supplying the market with “filet mignon steel”, as Dennis Zink, a consultant contracted by Xerox Corporation to manage the recycling program at its
Monroe County facilities, said, “For ground beef prices.” Scrap dealers and secondary smelters struggled to compete.

Near the end of 2003, the markets for recyclable materials began to improve again. The US economy began to grow. Currently, there is a high demand for metals, electronics and plastics in China and other Asian countries.

Many corporations have refocused their efforts on reducing their costs and looking for ways to improve on their bottom lines. What was once considered waste is now being re-evaluated to determine if it can generate income for the operation or, minimally, avoid costs associated with its disposal.

While there is a demand for plastics in overseas operations, plastics continues to present problems for the recycling program managers. In the past, rigid plastics, such as polycarbonate, were difficult to recycle because they were designed to have metal and foam attached to them with adhesives. Labels and paints also were undesirable. Design engineers have recently been developing products that would lend themselves to reusable or recyclable parts. While this has helped, plastics are still very difficult to recycle.

The main quality problem making it more difficult to recycle plastics is other plastics. To a plastics manufacturer, mixing resins is like putting broccoli in an apple pie and expecting it to still taste and look like an apple pie. One polyvinyl chloride (PVC) bottle among thousands of PET bottles can ruin an entire load. PVC mixed with PET makes the batch too runny in manufacturing new PET products. Manual separating among thousands of bottles is too costly (Aquino 61). It is also relatively inexpensive to manufacture new plastics compared to recycling used plastics. Because of these reasons, recycling solutions for rigid plastics come and go quite frequently.
Recycling of packaging materials has also been challenging. Some countries, like Germany, require recycled packaging programs, so that has helped. However, it is still difficult to recycle packaging materials. The largest barrier is associated with collection and transportation of the materials. Expanded polystyrene, known to many as Styrofoam, and stretch wrap take up considerable amounts of space and weigh very little. The resources, including employees and collection bins, that would have to be invested, are significant. Unless the operation had the ability to densify the waste, transportation costs would be enormous. Zink, of Integrated Recycling Services, likes to say, “It doesn’t make sense to spend a dollar to get fifty cents back.” Groups have decided that they would focus their attention on other waste streams.

3.2.2 Xerox – A Changing Face

In 2001, Xerox Corporation began changing its business model significantly as it looked for opportunities to reduce costs and generate cash flow. It started to outsource and relocate many of the manufacturing and assembly operations housed at the Webster site. These operations generated significant volumes of recyclable materials. Small machine shops began supplying Xerox with parts that were previously manufactured by Xerox in Webster, which has reduced the scrap metal significantly. The disassembly operations in Webster, New York were relocated to a Xerox facility in Cincinnati, which resulted in Xerox’s Cincinnati site having a higher recycling rate than the Monroe County facilities. As the operations were relocated, the effort focused more on quickly clearing out the facilities and less on properly segregating non-hazardous solid wastes.
Since 2001, Xerox has been relocating offices housed in leased facilities within Monroe County to the Webster site as space has become available. Many of these organizations are unaware of the recycling program in Webster and may not use the proper recycling containers.

Xerox Corporation underwent a significant right-sizing campaign, which resulted in many people leaving the company. Many of these people were involved in the development of the recycling program and understood the importance and benefits that it brought. Some of their replacements were less knowledgeable in the program. Corporate EH&S also underwent its own changes. Because of its own limited resources, it turned the major focus on regulatory compliance. Additionally, the facility maintained its recycling rate over the three-year period, so the urgency to make improvements was not present.

The company has completed its "turn-around" initiatives. Xerox Corporation's Monroe County facilities have a renewed focus on improving the recycling performance and achieve the recycling rate of the rest of the corporation. This will also result in an improved corporate recycling rate.

All ISO 14001 registered operations in the United States have an objective to improve their recycling programs. The waste is being analyzed to determine the effectiveness of the segregation process as well as finding opportunities to develop new recycle streams. Efforts are being made to make the employees more aware of the importance of recycling for the environment as well as the overall bottom line to the company. This, in turn, should help preserve jobs in Monroe County.
3.3 Conclusions

While recycling has been around forever, it has only recently found itself in the spotlight. Corporations view recycling as an important part of doing business. It can be used as a marketing tool and it can significantly reduce the overall cost of production. Consumers are much more aware of the environmental impacts of the goods they purchase and are putting demands on the corporations to design products that are environmentally friendly.

The adoption of ISO 14001 has resulted in helping operations identify their areas of environmental inefficiencies. The facilities have used this as a tool to continually improve their operations and reduce waste or find alternative methods for managing their wastes.

However, once a program has matured, one can't rest on its laurels and assume that it will continue to manage itself. Efforts must be made to maintain the program in an effective manner. While the level of involvement can be reduced, someone must continue to oversee the program and monitor the trends.
4.0 Methodology

The purpose of this study was to review the recycling program of a large multi-functional facility and identify opportunities to improve the program and the recycling rate of the facility. This study was conducted through a variety of means; which will be discussed in this chapter.

4.1 Tasks and Objectives

4.1.1 Review of Current Program

Elements of existing recycling program at a large multi-functional facility were reviewed to determine how the recycling rate is being measured. An interview was conducted with personnel responsible for developing the recycling program in the past.

4.1.2 Waste Generation and Disposal Analysis

4.1.2.1 Determine Waste Management Practices

Historical data of waste volumes was reviewed and the types of waste currently being generated at the facility were determined.
4.1.2.2 Analyze Waste Management System

Locations and conditions of existing waste and recycling containers were evaluated. The flow of material through the facility was evaluated.

4.1.2.3 Perform Waste Composition Analysis

Building-specific waste compactor and roll-off container studies were conducted through a third party waste hauling vendor. A visual observation of the studies was made. Waste studies were conducted for smaller dumpsters throughout the facility. The waste volumes were estimated by category. The percentage of recyclable materials in the waste stream was calculated.

4.1.3 Benchmarking

4.1.3.1 Internal Benchmarking

The recycling programs of two North American facilities within Xerox Corporation, ESSO – Cincinnati, Ohio and OKC Toner Manufacturing – Oklahoma City, Oklahoma were reviewed. These facilities were selected because they are similar to the Webster
facility in terms of production and manufacturing. The facilities also have very effective recycling programs. Interviews were conducted with program manager at each facility. The interviews were followed up with questions via e-mail.

4.1.3.2 External Benchmarking

The websites of several companies that manufacture electronic office equipment for their recycling programs and performances were reviewed. Those data were compared with the Monroe County facilities.

4.1.4 Review Monroe County Requirements

An interview was conducted with Monroe County Department of Environmental Services personnel to investigate opportunities to improve the accuracy of the calculated recycling rate.

4.1.5 Review Reuse Estimates

Opportunities to improve the accuracy of estimated internal reuse volumes at the facility were investigated through interviews and data collection.
4.1.6 Plastics

Historical and current issues associated with plastics recycling were reviewed.

4.1.7 Communication

Recycling awareness refresher training was conducted through a third party vendor. An interview was conducted with the vendor to assess the feedback from plant personnel as well as pervasiveness and effectiveness of the program.
5.0 Results

The first step in the methodology of this project was to review the current recycling program at Xerox Corporation’s Monroe County facilities. Included in this step were the review of the history of the program and the current processes. The second step in the methodology of the project was to review the recycling programs of other Xerox facilities and other companies. The first objective of these tasks was to determine whether opportunities exist to improve the current recycling program and recycling rate at Xerox Corporation’s Monroe County facilities. The second objective was to identify where those opportunities exist and how they could be implemented.

5.1 Results of Current Program Review

Elements of the current recycling program at a large multi-functional facility were reviewed to determine how the recycling rate is being measured. Opportunities were sought after that would improve the accuracy of the recycling rate while increasing the recycling performance. Additionally, an effort was made to understand the historical issues of implementing the initial recycling program. Because the program seems to be robust and effective, there should be little effort on re-inventing the program.

An interview was conducted with Joseph Stulb, P.E. – Manager, EH&S Assessments and Remediation, Xerox Corporation. Stulb was the manager of the operation that developed and implemented the recycling program during the early 1990s.
Stulb indicated that the recycling program was initiated by the organization that managed the buildings and occupants' workspaces in response to the recycling law passed by the Monroe County Legislature in 1991. Initially, the program focused on paper, OCC and pallet recycling. It was bare bones by today's standards. As opposed to getting Senior Management support, there was a grass roots effort, which Stulb attributes to its early success. Environmental teams, comprised of salaried and union personnel, were established throughout the Webster facility. Each team championed the recycling initiatives for their areas of responsibilities.

Eventually, the recycling program was transitioned to EH&S. A waste vendor was brought in to assist in its development and implementation. Utilizing the vendor's expertise, EH&S was able to make the program very successful. As the operations realized significant financial benefits from improved separation of recycle streams, it was easy to get their support. The recycling rate for Xerox Corporation's Monroe County facilities increased from about 60% initially to about 85%. Stulb said that EH&S attempted to roll the recycling program out to a few other locations. However, many of the other Xerox facilities were on their own. Best practices were not communicated throughout the organization.

Existing practices were reviewed in a variety of locations and operations to determine if and where the program was still being executed effectively. The review was measured against the initial program as a means to find breaks in the process. As the program matured and began to be self-sufficient, the responsible organization shifted focus to other issues and assumed the program would continue to run itself.
5.2 Waste Generation and Disposal Analysis

5.2.1 Waste Management Practices Determination

Historical data of waste volumes were reviewed to find trends in types of wastes as well as the total amount of waste generated. Data, summarized in Table 5.1 below, were available from 1997 through 2004.

The types of waste that are currently being generated at the facility were categorized to enable year over year comparisons. The waste streams were separated into white and mixed paper, corrugated cardboard (OCC), newspapers, magazines, food and drink containers, metals, electronics, toner, plastics, wood, others (e.g. concrete, glass, etc.), and refuse. Currently, with the exception of the refuse, all waste streams are reused internally and recycled or utilized as an energy source (Waste-to-Energy) externally.

<table>
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<td>2766</td>
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<td>48</td>
<td>56</td>
<td>29</td>
<td>22</td>
<td>25</td>
<td>96</td>
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<td>1894</td>
<td>2010</td>
<td>1901</td>
<td>1926</td>
<td>1661</td>
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<td>669</td>
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<td>579</td>
<td>401</td>
<td>270</td>
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<tr>
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<td>3726</td>
<td>5622</td>
<td>2039</td>
<td>1823</td>
<td>1813</td>
<td>2420</td>
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<tr>
<td>Other</td>
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<td>1779</td>
<td>19</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>94</td>
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<td>4234</td>
<td>3262</td>
<td>2742</td>
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<td>80.0%</td>
<td>77.0%</td>
<td>79.2%</td>
<td>74.5%</td>
<td>76.6%</td>
<td>80.6%</td>
<td>77.9%</td>
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Table 5.1: Waste Trends - Xerox Corporation Monroe County Facilities (tons)

The data shows that the recycling rate has been relatively flat over the sample period. However, there have been significant shifts in volumes of the individual waste streams that were generated. These shifts can be attributed to the changes that have occurred at
the facilities over the same period. In 1998 and 1999, large decommissioning activities were underway as some of the photoreceptor operations were relocated to other Xerox facilities. The decommissioning activities resulted in additional scrap metals.

In the late 1990s, governmental agencies began to tighten the regulatory requirements for managing electronic waste (e.g. PCs and monitors). Computers, particularly monitors, contain lead, mercury, and other heavy metals and hazardous materials that could fail a TCLP test. The TCLP test is used to determine if a waste contains a toxicity characteristic that could potentially leach into the soil and contaminate the groundwater. The requirements stated that a facility must recycle its surplus PCs or manage them as hazardous wastes. Landfill disposal is no longer an option.

Internal reuse programs suffered as the assembly operations were outsourced. This impacted the wood and OCC reuse and recycling volumes. The amount of newspapers, magazines, and food and drink containers has decreased over the period as well. This can be attributed to the decreased number of employees at the facilities that follow the recycling program.

While the volumes of the recycle streams have decreased, the amount of waste that is sent to the landfill has also decreased over the sample period. The decrease is a result of significant changes in the use of the Webster facility. Figure 5.1 summarizes the waste trends listed in Table 5.1.
5.2.2 Waste Management System Analysis

Walkthroughs of a few selected Xerox buildings were completed to evaluate the locations and conditions of existing waste and recycling containers. The buildings were selected to represent a cross-section of the different types of operations that occur at Xerox Corporation’s Monroe County facilities. Offices, manufacturing areas, labs, and machine test areas were closely reviewed and analyzed to determine the potential issues that should be addressed. Containers, recycling collection centers, and docks were evaluated to determine the flow of material through the facility.

Many of the printer and copier areas were equipped with the proper recycling and waste containers. Signs listing the acceptable items for each container were posted in some, but not all areas. The presence of paper in the trash containers provided evidence that not all employees are adhering to the recycling program. However, the amount of paper disposed of in the trash was small.
Wastebaskets within individuals’ offices were inspected for their contents. Some paper was found in the containers. Also, employees disposed of envelopes, brochures, and beverage containers. Many employees stated that they were unaware that they could recycle these items. They also requested small recycling containers for their offices that would enable them to accumulate recyclables.

Technicians in the machine and paper test areas primarily generated recyclable paper. They appeared to be following the correct procedures for recycling paper. Little to no recyclable materials were observed in the waste containers.

By and large, the recycling and waste containers in the manufacturing areas looked to be separated correctly. Occasionally, cardboard was placed in the waste container. It appeared that some areas are unaware of the current plastics recycling program because the employees were disposing of the plastic in the trash.

However, some dock areas showed evidence that the recycling process is not pervasive. Dock tippers, filled by the custodial staff, contained many recyclable materials. Cardboard boxes were thrown into the trash. Paper and recycle drink bottles were found in individual garbage bags collected throughout each building. The custodial staff has indicated that they find all types of recyclables in the trash during their rounds. However, they are not responsible to remove them from the waste stream.

5.2.3 Waste Composition Analysis

Alpco Recycling in Macedon, New York conducted studies of several building-specific waste compactors. Waste Management of New York, the waste hauler, delivered
randomly chosen waste compactor boxes to the facility over the course of several months. After the total weight of the contents was determined by driving the truck over a scale, the contents were dumped on the floor and sorted by hand by two Alpco employees. The materials were segregated into six piles; recyclable cardboard, paper, metals, plastics and wood, and trash. Each pile was weighed and percent by weight of each stream was calculated. The facility submitted reports; which were used in determining problem areas. Each compactor box was analyzed at least once and some were analyzed more than once. The results are summarized in figure 5.1.

![Figure 5.2: 2004 Waste Compactor Analyses](image)

Ideally, the contents of a waste compactor should be 100% trash. However, a waste compactor that contains up to 10% by weight of recyclable materials is considered to be very good. The chart above shows that some operations are very effective in segregating their wastes. It may also indicate that some of the areas do not generate large volumes of recyclable materials. The chart also shows that some areas are not managing their recyclable materials effectively. The waste compactor that is located in the 148 dock is
used by several people in three connected buildings, which is referred to as the West Complex. Employees in those buildings have not been trained in recycling for a long time. The custodial staff is required to transport materials from the buildings into Bldg. 148. It is easier for the staff to commingle the trash and recyclables.

The Bldg. 801 custodial staff does not segregate cardboard from the trash. One reason is the location of the cardboard compactor relative to the waste compactor. The cardboard compactor is located on the southeast corner of the building. The waste compactor is on the north side of the building. Xerox Square, a large office building located in the city of Rochester, does not have an effective recycling process for cardboard. The custodial staff has been instructed to throw out all small cardboard boxes. They recycle the large boxes. The building was constructed in the late 1960’s, so there was little emphasis placed on recycling. Because of this, there is little room available for recycling containers.

It was determined that the amount of solid waste generated in each building would aid in the assessment. Data were reviewed for the amount of waste removed from each compactor in 2004. The figure below summarizes those results.

![Figure 5.3: 2004 Waste Compactor Volumes](image-url)
The chart above shows the total waste generated in each building that utilizes a waste compactor to manage its trash. Bldg. 200 and 208 generated the largest amounts of waste in 2004. The buildings house assembly and manufacturing areas and warehouses. Xerox Square is mainly comprised of office employees on thirty-three floors. Building 801 houses office people and test labs.

The charts above are important when analyzing the current recycling program. Efforts should be made in areas that generate large volumes of waste that do not effectively segregate those wastes. This should result in the best opportunity to improve the overall recycling performance of Xerox Corporation’s Monroe County facilities. The charts show that efforts should be made to improve awareness and accountability in Bldg. 200, 208, the West Complex and Xerox Square. Additionally, processes should be reviewed for opportunities of continual improvement.

Smaller trash dumpsters and roll-off containers were reviewed at the Xerox facility in Webster, New York. Visual observations were made and the amounts of recyclable materials within the waste containers were estimated. However, it was difficult to quantify the amount of recyclable materials in the waste containers based on the visual observations.

Markets were explored for newly identified recycle streams such as packaging materials. No additional markets have been developed. However, the effort continues.

5.3 Benchmarking Results
5.3.1 Internal Benchmarking Results

The recycling programs of two North American facilities within Xerox Corporation, ESSO - Cincinnati, Ohio and OKC Toner Manufacturing - Oklahoma City, Oklahoma were reviewed. These facilities were chosen because there are similarities between them and the Monroe County facilities. Additionally, the facilities’ recycling performances equals or surpasses the Monroe County facilities.

Annually, each facility within Xerox Corporation submits data on its environmental performance. Solid waste and recycling are two components of that data. A comprehensive review of the solid waste and recycling data submitted from 2000 though 2003 was completed. Trend analysis of the recycling performance at each facility was conducted.

5.3.1.1 ESSO – Cincinnati, Ohio

The Surplus Equipment Center (SEC) in Cincinnati, Ohio tears down printers and copiers that have been returned from customer locations. This operation is a critical step in Xerox Corporation’s equipment remanufacturing initiatives. Since the early 1990s, Xerox’s equipment remanufacture and parts reuse/recycle program has kept over 1.5 billion pounds of waste out of landfills — the equivalent of more than 2.3 million machines (Xerox 2004 Progress Report 14). Remanufacturing has proved to be a sustainable business model for the company. Many components have useful life after a machine has been removed from the field. The organization sends surplus machines to
an outsourced operation, Flextronics – Aguascalientes, Mexico, to be remanufactured and returned to the supply chain.

The Equipment Strip-Scrap Operation (ESSO) is a subset of the SEC. ESSO tears down all surplus equipment that is not needed for remanufacturing and separates the components into waste streams (see Table 5.2). The facility has developed several recycling outlets for the waste streams; which has resulted in little waste being sent to the landfill. The Cincinnati operation is also tasked with removing the needed components to supply customer service engineers.

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Toner</td>
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<td>0</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Toner</td>
<td>Landfill</td>
<td>1085</td>
<td>1004</td>
<td>1370</td>
<td>1197</td>
</tr>
<tr>
<td>OCC</td>
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<td>3613</td>
<td>3528</td>
<td>4181</td>
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<tr>
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<td>20</td>
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<tr>
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<td>Recycle</td>
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<td>16</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Metal</td>
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<td>24383</td>
<td>27495</td>
<td>23940</td>
</tr>
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<td>Reuse/Recycle</td>
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<td>765</td>
<td>255</td>
<td>332</td>
</tr>
<tr>
<td>Plastics</td>
<td>Recycle</td>
<td>223</td>
<td>554</td>
<td>388</td>
<td>239</td>
</tr>
<tr>
<td>Paper</td>
<td>Recycle</td>
<td>57</td>
<td>60</td>
<td>58</td>
<td>53</td>
</tr>
<tr>
<td>Refuse</td>
<td>Landfill</td>
<td>1971</td>
<td>1395</td>
<td>1555</td>
<td>1317</td>
</tr>
</tbody>
</table>

Table 5.2: ESSO Cincinnati Operations (tons)

Xerox Corporation’s facility in Cincinnati employs approximately 160 people. The operation generates large volumes of recyclable scrap metals as part of its business. The amount of scrap metals dwarfs all other wastes; which lends itself to high recycling rates. Martha Stegbauer indicated that the facility’s long-standing and positive relationship with the scrap metal recycling vendor has proven favorable to the program.

Stebauer noted, however, that the facility struggles to find an outlet for its waste toner and toner cartridges. If the facility can find a viable solution for the toner cartridges, it should achieve nearly 100% recycle rate.
The facility identified solid waste as one of the significant environmental impacts as defined by the ISO 14001 standard. Responsible people developed recycling outlets for plastics, glass and monitors in an effort to reduce the landfilled waste. ISO 14001 was the avenue to facilitate the changes. The employees receive recycling training as an element of the annual ISO 14001 Refresher training. According to Stegbauer, a site manager manages the facility and makes the employees accountable by coordinating quarterly audits to ensure the recycling processes are being followed.

5.3.1.2 OKC Toner Manufacturing – Oklahoma City, Oklahoma

The OKC Toner Manufacturing Operation in Oklahoma City, Oklahoma manufactures toners, developers, and binder tape for several Xerox products. OKC also manufactures raw materials that are used in toner manufacturing at other Xerox facilities, including the Webster Toner and Developer Plant. The facility’s 180 employees manufacture or support the manufacturing of the finished goods. The Plant Manager is responsible for the overall performance of the facility. Each employee at the site reports through the Plant Manager.
Toner is the largest volume of waste that the facility generates. OKC has been able to develop a recycling outlet. A cement kiln uses the waste toner as a fuel source for its operation. Jim Warram, the Environmental Engineer, stated that the facility does not get full participation in the recycling program from its employees, but they are not held accountable for participation. The plant recognizes individuals for their efforts and suggestions.

A key to the effectiveness of the recycling program at Xerox Corporation’s OKC facility is the support it receives from the Plant Manager, senior staff and environmental champions. The employees see that recycling is an important and integral way of doing business. Additionally, the engineers structure the recycling programs within the manufacturing processes so that recycling is not added on. “The performance is a result of the plant’s efforts,” Warram said.

### 5.3.2 External Benchmarking Results
Benchmarking of other companies is another method used to determine the effectiveness of the recycling program of Xerox Corporation’s Monroe County facilities.

5.3.2.1 Canon Incorporated

Canon has adopted an approach that is similar to Xerox Corporation for resource recycling. The Canon Group is aggressively pursuing Inverse Manufacturing* (IM) as part of its dedication to being a global corporation supporting a recycling-oriented society. The essence of this effort is the maximization of resource efficiency by implementing a high-level business activity life cycle system that considers resource recycling from both development and design stages.

Canon's IM has been implemented through a global structure for recycling, with centers in the Americas, Europe, and Asia. Sharing of information and resources between these regions makes it possible to realize global recycling. Collected products are reused as resources in order to conserve precious raw materials, making it possible to reduce the environmental burden and improve economic efficiency (Canon 1).
Canon has strategically placed recycling centers throughout the world; which lends itself to supporting the IM concept. The figure below shows the positive impact that inverse manufacturing can have on the environment and the company’s sustainability. Designing products using the IM concept results in widespread benefits in costs, inventory control and waste reduction.

![Figure 5.4: Canon Inc. Global Recycling Structure](image)

*Figure 5.4: Canon Inc. Global Recycling Structure*

![Figure 5.5: Inverse Manufacturing Drop – Canon Inc.](image)

*Figure 5.5: Inverse Manufacturing Drop – Canon Inc.*
The 3Rs—“Reduce,” “Reuse,” and “Recycle” form the basis of IM activities. To put this approach into practice, products are designed from the development stage for longevity, compactness and ease of disassembly. A collection and processing system for used products is established. Recycling technology is developed. Used products are actually reused and recycled.

Canon strives to use common parts in products as much as possible. They have succeeded in developing products that are highly reusable and recyclable, while still maintaining the safety and easy disassembly of products. It also continues to aggressively research and develop recycling technology in order to clear the high legal hurdles facing the use of reused plastic materials. The fruits of this research are being incorporated into more and more products (Canon 1).

The Canon Group has expanded its copying machine remanufacturing program globally since 1992. Remanufacturing begins with the collection of used products and the selection of parts according to rigorous criteria. Selected parts are thoroughly cleaned and worn parts replaced to ensure that the reused materials meet the same high quality standards applied to new parts.

Canon also initiated the TREE recycling program in 1999 as a way to effectively reuse machine parts. Short for “Technology of Reusing for Environment with Economy,” the TREE program does not simply involve the recycling of used products. Rather, parts removed from used products are reused in other machines, promoting an effective use of resources.

Canon has developed a recycling program for consumable products. Since 1990, Canon has been operating a Toner Cartridge Collection and Recycling Program on a
global scale. Collected cartridges are separated by machine type, and parts that can be used again are reused or recycled.

Canon Ecology Industry Inc. (CEI) has advanced the recycling of toner cartridges with the introduction of a fully automated and specially designed plant that went on-line in 2002. Collected toner cartridges are simply placed into an apparatus that automatically separates the steel, aluminum, HIPS (high-impact polystyrene), and other plastics. The recovered HIPS is highly pure and has achieved flame resistance standards as certified by UL, allowing it to be reused in cartridges as part of the closed material recycling system.

![Figure 5.6: Toner cartridge recycling plant (CEI)](image)

Conducting development, production, use, collection, and recycling all in the same region has enabled a life cycle that both reduces environmental burden and realizes economic efficiency.

The collection of used ink cartridges began in 1996. As of February 2003, more than 3,000 stores across Japan were cooperating in the collection of used cartridges. The collected ink cartridges are sent to CEI for separation. Plastic and metal materials are separated for recycling and reuse, while all other materials are converted to heat energy and 100% recyclable.

Beginning in 1999, Canon set up a plastic collection system across eastern Japan for mainly exterior parts of machines. In 2002 it expanded the program nationwide to include the paper supply cassettes for copying machines. The collected paper supply
cassettes (HIPS material) are preprocessed in Japan for washing and the removal of foreign substances, then shipped to Thailand. There, a local plastic producer pulverizes the plastic and recycles it into m-PPE (modified polyphenylene ether resin). The recycled plastic has obtained UL electric safety standard certification and meets the same quality standards as virgin plastics. This recycled plastic is used as material for the power supply box cover in inkjet printers (Canon 1).

The figure below shows the flow of the processes that allow Canon to re-introduce plastics into its manufactured goods.

![Flowchart of recycling process](image)

**Figure 5.7: Materials Exported from Japan to Thailand**

In 2001, Canon adopted molded parts made from 100% recycled PET, for the main parts of laser beam printers. It prioritizes the use of 100% recycled PET parts for copying machines, facsimile machines, and other products. In 2003, the amount of recycled PET used by the Canon Group grew to 750 tons (Canon 1).
5.3.2.2 Dell Incorporated

Through the company's Reduce, Reuse, and Recycle (R3) initiative, all Dell manufacturing facilities have permanent recycling operations that have resulted in significant waste reductions. These sites collect more than 10 different materials, including cardboard, office paper, plastics, foams, metals, batteries, disks, and pallets.

Dell has aggressively worked to systematically identify new opportunities for reducing waste and achieving related cost savings. Dell manufacturing facilities are saving approximately 200 tons of cardboard boxes and packing foam annually by reusing boxes for parts and components. The boxes are used to ship replacement parts to customers and service vendors. A business process improvement team is working on ways to increase this utilization.

In mid-2002, Dell began a program to recycle plastic and foam in a desktop computer manufacturing facility and eliminated production of approximately 1300 tons of landfill waste annually. In March 2003, Dell began recycling plastic and foam in a server manufacturing facility. This program will reduce landfill waste by an estimated 120 tons annually.

Using information gathered from successful R3 programs initiated in the U.S., environmental and facilities managers in Austin are working closely with other Dell regions to identify similar ways to reduce the company's solid-waste stream worldwide. Dell's R3 program has received recognition for its environmental excellence by local and state organizations, including Keep Austin Beautiful, the Austin Corporate Recycling
Council, the Recycling Coalition of Texas, and the Texas Commission on Environmental Quality (Dell 1).

![Dell Recycling, Reuse, and Landfill Rate](image)

**Figure 5.8: Dell Recycling, Reuse, and Landfill Rate**

Dell has a worldwide 20% landfill rate. The environmental performance of the company has continued to improve over the last several years. Dell has implemented a program of sharing best practices within the company as a means to continue the positive trends. Dell’s worldwide reuse and recycling rate is similar to the Monroe County facilities of Xerox Corporation.

### 5.4 Results of Monroe County Requirements Review

A brief telephone interview was conducted with Russell Rutkowski. Mr. Rutkowski is an associate engineer in the Solid Waste Program for the Monroe County Department of Environmental Services. He indicated that the department is very pleased with Xerox Corporation’s recycling initiatives within Monroe County. He also stated that Xerox
Corporation contributes significantly to the overall recycling rate of the municipality. Mr. Rutkowski could not provide data for other companies in the Rochester area.

Mr. Rutkowski confirmed that Xerox Corporation’s Monroe County facilities should also account for all surplus equipment that is being sold through other channels. "If a material is sold that would have otherwise been sent to the landfill, Xerox should get credit for that," he said. Currently, Xerox is not tracking surplus items that are being resold.

5.5 Reuse Estimates

Monroe County Department of Environmental Services allows a facility the ability to include materials and goods that are reused when determining the recycling rate. Additionally, surplus goods that are sold, may also be included if the goods would otherwise be disposed of as wastes.

The Xerox facilities in Monroe County do not capitalize on fully including reuse data. Currently, one operation has estimated the amount of pallets, cardboard boxes, and packaging materials it reuses internally. While it is a large operation on the Webster site, there are other large operations that also reuse boxes and pallets that have not been included in the estimate.

Additionally, Segregated Excess, a Xerox operation within Monroe County, exists for the purpose of managing inventory and growing revenue for the corporation through sales of obsolete and surplus goods. There is no tracking mechanism that would enable the
company to get environmental credit for those sales. Implementation should be easy because the operation must maintain thorough and accurate transaction records.

Xerox also is not fully capturing in reports volumes of electronic waste from the offices. Currently, there is a program for reusing and recycling computers and accessories, monitors and laptops. A computer is often redeployed from one employee to other Xerox employees after it has been modified. Obsolete equipment is recycled. Once again, a disconnect exists between the operation and the organization that tracks and reports on the environmental performance for the facilities.

5.6 Plastics

Plastics present barriers for the recycling initiatives at Xerox Corporation's Monroe County facilities. The facilities generate plastics that are not easily recycled. Many of the rigid engineered plastic parts that are processed at the Webster facility are from older office equipment families. At the time of their designs, the design teams did not consider the recyclability of materials. The parts may contain brominated flame retardants. Additionally, there are metal and foam attachments. The attachments and flame retardants present real challenges for plastics recyclers. It is costly to invest labor to remove the attachments; therefore many plastics recyclers will not entertain the idea of accepting the parts.

The design teams just began using the coding system for plastics (see table) over the last several years. Many of the parts that are passed through the Webster facilities are not clearly identified.
<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Environmental capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene terephthalate PETE (#1)</td>
<td>A rigid, transparent plastic resistant to chemicals and moisture; common usage is soft drink bottles. Can withstand heat; used in freezer-to-stove bags. PETE is sometimes abbreviated at PET.</td>
<td>Frequently recycled.</td>
</tr>
<tr>
<td>High density polyethylene HDPE (#2)</td>
<td>Commonly used for milk jugs, heavy-duty trash bags, butter tubs, bleach bottles, and base cups for large soft drink bottles. Opaque and stronger than LDPE.</td>
<td>Frequently recycled.</td>
</tr>
<tr>
<td>Polyvinyl chloride PVC or V (#3)</td>
<td>Used in some shampoo bottles, detergent bottles, food wraps, cooking oil bottles, and water bottles. PVC is an excellent barrier to gas and liquid. Burning produces toxic gases.</td>
<td>Rarely recycled.</td>
</tr>
<tr>
<td>Low density polyethylene LDPE (#4)</td>
<td>Commonly used as clear wraps of bags, supermarket produce bags, and bread wraps. Also used for stretch wrap and other packaging.</td>
<td>Rarely recycled, although improved opportunities recently.</td>
</tr>
<tr>
<td>Polypropylene PP (#5)</td>
<td>Commonly used in syrup bottles and yogurt containers and some containers for detergents, shampoos, and medicines, as well as screw-on caps and food lids.</td>
<td>Rarely recycled.</td>
</tr>
<tr>
<td>Polystyrene PS (#6)</td>
<td>Commonly used in crystal (clear plastic cups) and foam (coffee cups, packaging material, and fast food clamshells).</td>
<td>Increased recycling opportunities. Expanded polystyrene is bulky and difficult to recycle unless compressed.</td>
</tr>
<tr>
<td>Other mixed resins (#7)</td>
<td>All other resins.</td>
<td>Rarely recycled.</td>
</tr>
</tbody>
</table>

Table 5.4: Coding System for Plastics Containers (Society of Plastics Industry)

Another problem facing Xerox Corporation is the recyclability of spent toner bottles and cartridges. The design teams have been able to develop reuse opportunities for some of the bottles and cartridges. However, many of the products cannot be reused. While they are manufactured from polypropylene and HDPE, a frequently recycled plastic, residual toner in the bottles and cartridges makes it difficult to recycle. Crushing and grinding of the bottles can result in toner dust being spread throughout the recycling vendors’ facilities. This presents them with safety and quality issues that they, for obvious reasons, choose not to accept.
Plastics used for packaging also present problems for Xerox Corporation's Monroe County facilities. The materials are bulky and take a large volume of air space for their weights. Currently the facilities have no means to densify the materials that would result in more efficient transportation. Because of this, the facilities do not recycle packaging materials currently.

5.7 Communication Results

When the recycling initiatives were disseminated across Xerox Corporation's Monroe County facilities, the environmental teams provided training to the employees. However, refresher training has not been performed for several years. In 2004, recycling training was developed as a means to improve employees' awareness. The training was about 20 minutes long and covered topics specific to non-hazardous recyclables, such as metals, cardboard, and paper.

In 2004, the training was provided to 567 manufacturing and support staff over forty sessions. There was a complete spectrum of opinions about the effectiveness of the training. Overall, however, it was received well. A questionnaire was provided to every employee that received the training, which will be helpful in addressing areas of concern. More than half of the employees, 296, that attended the training, completed the questionnaire.

Employees were asked about the usefulness of the training. Two hundred nineteen responded favorably, while 64 employees found the training somewhat useful. Thirteen respondents did not find the training useful. Similarly, 221 employees found the material
presented in an interesting manner. Sixty-five employees found it somewhat interesting and ten employees did not find the material interesting at all. When asked if the employees felt that the training would enable them to better recycle at work, 198 agreed, 80 respondents felt the training would enable somewhat better recycling at work. Eighteen employees did not think the training would assist them in recycling at work.

Distribution of Employee Responses

![Distribution of Employee Responses](image)

Figure 5.9: Results of Employee Training Questionnaire

About 75% of the employees asked felt that the training was useful and interesting. However, only 67% felt that the training would enable them to recycle better at work. Many employees suggested that the training would be more useful in other areas, such as the office areas. Additionally, the employees wanted to see training adapted to meet their areas including examples of the wastes they generate. They did not find the general training as meaningful to them.
6.0 Analysis and Discussion

This chapter discusses and analyzes the results found in the project. Topics that will be addressed include how the current recycling program at Xerox Corporation’s Monroe County compares to other Xerox facilities and whether opportunities exist to improve the program by adapting best practices from those facilities. Another question to be explored is whether Xerox’s Monroe County facilities are effectively managing their recycling programs. This will be discussed by comparing other companies and their recycling practices and performances. There are opportunities to improve the recycling rate in the Monroe County facilities through a number of channels, which will be discussed later in this chapter.

6.1 Compare and Contrast Xerox Corporation’s Recycling Programs

The facilities included in this project are very different from each other. The Monroe County facilities are large with many buildings and employees. Many organizations may be located within the same building. It is difficult to maintain awareness of the recycling initiatives in each area because groups are being moved around quite often as the company continues to move out of leaseholds within Monroe County. The employees do not completely understand the process. There is no accountability for those who do not follow the process. They have not received routine training in many years. Additionally, there is little recognition for people that find ways to enhance the recycling program.
Xerox Corporation’s operations in Cincinnati (ESSO) and Oklahoma City (OKC), however, have small facilities; which are housed within one or two buildings. It is easier to develop processes for material flow that enable proper segregation of recycle streams. Xerox’s facility in Cincinnati generates large volumes of scrap metals annually. The volume of scrap metals dwarfs the volumes of other combined wastes. The nature of the organization’s business lends itself to a high recycling rate. The office staffs are small relative to the staffs in the Monroe County facilities. There are opportunities to improve the recycling performance in the office areas.

There does not seem to be great difference in the recycling programs of each of Xerox Corporation’s facilities reviewed for this project. Therefore, there are not obvious changes that can be taken from the recycling programs in the ESSO and OKC facilities that will result in significant increase in recycling rate at Xerox’s Monroe County facilities. Additional efforts should be made to share information between all Xerox facilities. The shared information may actually aid the ESSO and OKC facilities more than the Monroe County facilities.

6.2 Compare and Contrast Xerox - Monroe County Facilities with Other Companies

Xerox Corporation has a “Zero-to-Landfill” initiative. The initiative was started in the Monroe County facilities. The company has been able to achieve a 91% reuse-recycle rate for its 22 manufacturing and support operations worldwide. The Monroe County facilities have a reuse-recycle rate of about 80%; which is significantly lower than the rest of the corporation. It was important to understand how the Monroe County
facilities compare to other companies. This understanding should assist in determining how effective Xerox’s recycling program is in Monroe County. Xerox Corporation’s Monroe County facilities may not be able to improve on the recycling rate without a substantial financial cost to the company.

Dell Incorporated was selected because it manufactures and distributes electronic office equipment. Dell reuses and recycles many of the wastes that Xerox reuses and recycles. However, Dell has established a recycling process for foam and plastic packaging. Xerox Corporation’s Monroe County facilities do not have a process to recycle similar materials. It has been believed to be cost prohibitive to recycle them. The Monroe County facilities have a recycling performance that is as effective as Dell’s manufacturing facilities worldwide. Dell Incorporated has received recognition and awards from governmental and non-governmental organizations for its recycling program. In the author’s opinion, this indicates that Xerox’s Monroe County facilities have an effective recycling program because the facilities have a better recycling performance than Dell. However, there is an opportunity for continual improvement.

Canon was chosen because its core business is manufacturing network printer and copier equipment. It is a competitor of Xerox Corporation, so it was assumed that the wastes would be similar. The results of the project confirmed the assumption. Canon has realized great benefits from its IM and TREE remanufacturing processes. As was stated earlier, Xerox Corporation has a mature remanufacturing program that has saved the company millions of dollars while eliminating waste from the landfill over the last several years. The retooling of the Xerox Corporation’s Monroe County facilities has resulted in a decrease of remanufacturing there. However, many other Xerox and Xerox
suppliers continue to benefit from the program. Canon has developed a process to recycle many of the toner cartridges and other supplies. Xerox Corporation should consider reviewing Canon's processes in an effort to reduce the amount of cartridges and bottles that are sent to the landfill or a waste-to-energy facility.

6.3 Opportunities to Improve Xerox's Monroe County Facilities' Recycling Rate

This project has shown that Xerox Corporation's facilities in Monroe County are recycling very high percentages of the waste generated. The program has continued to function in spite of the changes in personnel and operations. While the recycle rate has fluctuated slightly over the last five years, it has remained relatively constant. Monroe County Department of Environmental Services has been pleased with Xerox's contribution to the county's overall recycling performance.

This project has identified potential opportunities to improve the recycling program at Xerox Corporation's Monroe County facilities, which in turn should improve the recycling rate. Many employees commented that they are unaware of the correct recycling procedures. An awareness campaign should result in improved segregation of materials. Research has shown that the recycling vendors have changed their processes that allow them to receive materials that, in the past, were not recyclable. Many of the communications do not reflect those changes. Additionally, the training should be cascaded through the offices and research areas. When the program was implemented during the 1990's, many of the smaller areas were not included in the large campaign. They were provided with the right containers, but they received little attention otherwise.
Unless recycling is important to an individual, he or she is less likely to go through the effort of segregating wastes. Currently, the custodial staff blames the office people and the office people blame the custodial staff for recyclable materials that are thrown in the trash. There are four scenarios for the flow of recyclable materials from the point of generation to being shipped off-site. Ideally, an employee that generates the recyclable material puts it into the proper container and the cleaner or mover then puts it into a much larger container for recycling. Sometimes, however, an employee might put the recyclable material into the right container, but then the cleaner or mover throws it all into the trash or an employee might throw the material into the trash and the cleaner will then have to throw it out, since it is not the cleaner’s job to sort through people’s trash. Employees should be made accountable for not following the recycling processes; which is consistent with Xerox’s other management methods.

The waste compactor analyses and waste generation volumes show that efforts should be made in Xerox Square, as well as Bldg. 801, 208, and the West Complex. Nearly 25% of the material in the waste compactors was cardboard. Each of the facilities has processes in place for recycling the cardboard. It is apparent that the processes are not being followed. A more detailed review of these areas should be conducted to improve their performances.

A better method for tracking reuse data should be developed to ensure all areas are included and the estimated volumes are accurate. Additionally, recycling of plastics has been difficult to sustain. Efforts should be made to continually search of outlets for plastics. Typically, when an outlet is identified, little effort is put forward to find alternatives to that outlet. This has resulted in storage of tremendous volumes of plastics
at an expense to Xerox Corporation. Ultimately, the plastics would end up in the landfill in many instances, which would result in lowering the recycling rate for that year.
7.0 Conclusions

7.1 The Most Important Results

There are many important findings and results from this project. Before the project commenced, it was assumed that Xerox Corporation’s Monroe County facilities should be able to reuse and recycle at the same rate as the rest of the company’s manufacturing facilities. It was also assumed that the recycling program had matured and was self-sustaining. Therefore, resources were allocated to other areas of concern.

The results of this project indicate that the Monroe County facilities of Xerox Corporation could improve the recycling performance. However, it would be difficult to achieve a 10% increase while still maintaining a cost-effective program. Opportunities should be explored to reduce the gap where it is appropriate.

Another important finding of this project is that enough resources need to be committed to the recycling program to maintain its effectiveness. The processes for some recyclables, such as plastics, change rapidly and significantly. Vendors and their requirements change frequently because of changes in market conditions and demand. In order to maintain an effective recycling program, an organization must monitor it continually. There must also be support from the facilities and managers. It is impossible to manage the program in isolation.

A third finding of significance is the need to share information and understanding of the recycling programs and processes across organizations and facilities. Small facilities
within Xerox Corporation, such as Cincinnati and OKC, may not have the resources available to react to changes in their recycling programs. This can have an adverse effect on their recycling performance. Information sharing can provide solutions to those facilities.

7.2 Uniqueness of the Project

This project was unique in that it examined an existing and mature recycling program that was thought to be able to be self-sustaining. The project did not require creating a recycling program. Rather, it looked more closely at the program for opportunities to enhance it. Internal and external benchmarking was conducted to measure the effectiveness of the program against other effective programs. Benchmarking was conducted using various method including interviews, e-mail correspondences, and web searches.

7.3 Meeting the Objectives of the Project

The goal of this project was to determine the effectiveness of a mature recycling program at a large manufacturing facility. Data indicate that Xerox Corporation’s Monroe County facilities are recycling and reusing materials at a very high percentage. However, the project has proven that opportunities exist that should increase to recycling rate of the facilities. Attention must be given to the program or it will begin to fall apart.
This project has shown the early stages of that. The project did answer the initial question.

Some results were unexpected. The original hypothesis was that the Monroe County facilities could benefit from learning about other Xerox facilities’ recycling programs. The project showed that the other facilities do not have better recycling programs than the facilities in Monroe County. Their business models, waste types, and organizational structures just lend themselves to recycling high percentages of the waste generated.

Existing theory is that Xerox’s Monroe County facilities should continue to improve the recycling rate year over year. Also, the facilities should be at or above the corporate recycling rate because the “Zero to Landfill” program was initiated in Monroe County. The project results indicate that Xerox Corporation’s Monroe County facilities can improve their recycling rate slightly, but it will be difficult, given their complexities, to achieve the corporate rate. The facilities could send all non-recyclable waste to a waste-to-energy facility and claim to reuse and recycle 100% of their waste. However, this would be costly. That solution would also result in putting forth less effort in finding recycling outlets for some waste streams.

7.4 Implications of the Project

There are implications associated with this project. To effectively manage a recycling program, one must ensure that the tools are in place to properly collect and segregate all recyclable materials from those items that should be landfilled and do it
such that additional costs are not being absorbed just to maximize the recycling rate. Recycling should be viewed and managed as a smart way to do business.

Additional steps should be taken to ensure the effective management of the recycling program. Proper planning is necessary to ensure that employees are aware of the recycling processes. A plan would also be useful for analyzing waste compactors routinely to react to areas that were becoming less effective in source separation. Ongoing measuring and monitoring of the recycling program is also necessary to ensure its effectiveness.

Employee involvement is very important to the management of the recycling program. Their support and participation are critical in achieving the highest reuse and recycling performances at the facilities. Employees may have suggestions to improve the program. Employees with leadership skills and others interested in recycling may be able to utilize “peer-pressure” in getting their friends and co-workers to conform to the program requirements.

A team of individuals with varying degrees of responsibilities and contacts is key to the success of the efforts suggested above. This project showed that one individual is not able to address the issues alone. The task is too large and support is required to ensure items get addressed.

7.5 Opportunities for Follow-up Questions

Several questions were raised during this project that could lead to additional research and work. Areas of particular interest include: 1) the application of the cost-benefit
approach in selling the importance of reusing and recycling materials to Xerox Corporation’s Monroe County facilities, which can be done by resurrecting the 3R’s Savings Report; 2) the benefit of sharing information between facilities and other companies that would enhance each facility’s recycling programs; 3) what positively or negatively influences an individual to reuse or recycle at work; and 4) can this influence lead to improved recycling practices at home. A work plan will be developed to ensure the opportunities are realized.
Works Cited


Stegbauer, Martha. Interview via e-mail. 2005.
&CID=21&DID=21

http://www.epa.gov/wastewise/about/overview.htm


http://www.epa.gov/epaoswer/non-hw/muncpl/recycle.htm

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http://a1851.g.akamaitech.net/f/1851/2996/24h/cache.xerox.com/downloads/usa/en/e/ehs
_2004_progress_report.pdf

uide&Xcntry=USA&Xlang=en_US


Zink, Dennis. Oral communication.
Appendix A – 2004 Solid Waste and Recycling Report (Xerox Monroe County)

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<tr>
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<td><strong>Total Waste Landfilled</strong></td>
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<td>Recycle &amp; Reuse Rate</td>
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<td><strong>74.51%</strong></td>
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<td><strong>80.61%</strong></td>
<td><strong>77.90%</strong></td>
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All quantities are reported in tons.
Appendix B – Waste Compactor Analysis Form

ALPCO RECYCLING

DATE ____________________________
CUSTOMER _________________________
TYPE OF LOAD _______________________
WEIGHT ____________________________
PROCESS TIME _______________________
# PEOPLE ____________________________
HRS X PEOPLE _______________________
TIME PER TON _______________________

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<td>PLASTIC</td>
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<td>TRASH</td>
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Appendix C – Recycling Training Questionnaire

Feedback Questionnaire

1. Did you find the material presented interesting?
   
   Yes  Somewhat  No

2. Did you find the training useful?
   
   Yes  Somewhat  No

3. Do you feel that this will enable you to better recycle at work?
   
   Yes  Somewhat  No

4. Do you know of any other work group/organization that would benefit from this training? Provide name

5. Write any suggestion of comment that you feel could make the training more effective.

6. Please provide your name and telephone number if you would like a representative from EH&S to visit your work area.
   
   Name ___________________________  Telephone No. ___________________________

Thank you for attending the recycling refresher course and answering the questionnaire.

Date: ___________________________

Organization/Group Name: ___________________________

Your Name (Optional): ___________________________
Appendix D – Interview with Martha Stegbauer (Xerox Cincinnati) via e-mail

How many employees are at your facility? 162 (122 Union IWF and 40 salaried)

How do your operations develop recycling outlets? Individual or team? Combination of the two, in general a need is identified and then we try to find a vendor.

What things have gone well? Scrap metal recycling has gone well. We have had a long standing relationship with the scrap metal vendor and we work well together. What have you had problems with? Vendors for plastic and skids. They constantly don’t show up as needed etc. Currently, we are using Ryder trucks to transport the material since it is more reliable. Toner is a constant issue for recycling. That is the cartridges removed form the machines. The bulk toner is able to be recycled.

Do you include general waste (cafeterias, bathrooms, etc.) in the volumes you report to Corp EH&S? All of the waste is in the one category of trash landfill.

Do you conduct routine waste analyses? If yes, what is your process? No

Do you have regular refresher recycling training? Yes as a part of the ISO14001 training.

What level of support do you have (plant manager, etc.)? Site manager

Do you make employees accountable for their recycling efforts? If yes, how? Yes, they are to follow the process the same as any other documented work process. They are audited quarterly.

Who is responsible for the recycling efforts? Everyone actually but Venita Vivians is the one who audits and records the numbers.

Is the recycling performance a result of the efforts of the plant or a nature of your business? The majority is due to the nature of the business. But the additional ones like plastic, platen glass, monitors etc were developed to reduce the waste going to landfill (ISO14001).

Do you recognize individuals for their contribution to the recycling efforts? Not beyond the ISO14001 program. But we have recognized people for developing new processes but we just haven’t had any for recycling.

What are you doing with your e-waste? Send it to several recyclers - Dublak Glass, 5R processing, Gemstone Computers.

What types of regulatory requirements have your state and/or local agencies placed on you for a recycling program? None beyond RCRA/EPA
Appendix E – Interview with Jim Warram (Xerox OKC) via e-mail

How many employees are at your facility? 180

How do your operations develop recycling outlets? Individual or team? Individual. A team may form the program but developing outlets has proven to be better if one person is doing all the phone calls and emails.

What things have gone well? What have you had problems with? Participation rates, particularly for aluminum cans. Second problem has been outlets for recycling nontraditional materials.

Do you include general waste (cafeterias, bathrooms, etc.) in the volumes you report to Corp EH&S? Yes

Do you conduct routine waste analyses? Yes, but only on hazardous waste and non-hazardous industrial waste. If yes, what is your process? Hazardous waste - minimum of every three years conduct laboratory analysis with some waste streams relying on generator knowledge. Non-hazardous industrial waste - liquid waste streams are analyzed and solid waste streams are characterized by generator knowledge.

Do you have regular refresher recycling training? Annual environmental training module includes recycling.

What level of support do you have (plant manager, etc.)? Plant Manager, Senior Staff, and Environmental Champions.

Do you make employees accountable for their recycling efforts? No If yes, how?

Who is responsible for the recycling efforts? Environmental Engineer, unless delegated.

Is the recycling performance a result of the efforts of the plant or a nature of your business? Both. We structure our recycling programs within the manufacturing processes so recycling is not something added on. Therefore our performance is a result of the plant’s efforts.

Do you recognize individuals for their contribution to the recycling efforts? Yes. Good suggestions, new implementation ideas, individual efforts are mentioned in training classes and/or communication meetings.

What are you doing with your e-waste? Computers, monitors, and keyboards are collected in gaylords for recycling. Circuit boards are collected in 55-gallon drums.

What types of regulatory requirements have your state and/or local agencies placed on you for a recycling program? None.